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RHEOGRAPHY IN WEIGHTLESSNESS

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16. Abstract Special small-scale rheographic devices suitable for use on board a space ship have been developed and used during flights for the study of blood flow in various vascular regions. The results promote understanding of the processes that occur during space flight and make it possible to better understand the adaptation of the human body to weightlessness and to predict the future condition of the cosmonauts' health.					
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## RHEOGRAPHY IN WEIGHTLESSNESS

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During the years that have passed since the first manned space flight, space biology and medicine have accumulated not a little experimental data on the study of the body's response to the absence of gravity. /3\*

At present there is a certain opinion that in weightlessness the body's activity is directed at the establishment of new interrelations that are adequate for the changed environmental conditions. Already physicians can give a general evaluation of the condition of the body in space flight conditions and name those systems in which the most marked shifts are observed. In first place are the circulatory system and other systems that are responsible for the adaptation to weightlessness and the readaptation period after the cosmonaut's return to earth. The results of previous flights have shown that adaptability to weightlessness is accompanied by a reduction of the functional capabilities of the body to various effects, primarily, to gravitation.

Initially, at the dawn of piloted space flights, the arsenal of techniques and instruments used in flight conditions was very limited. The cosmonaut's condition was evaluated, as a rule, by means of basic vital signs: frequency of heart contractions, respiratory rate and arterial pressure. A complete clinical-physiological examination was carried out only before and after the flight. With the increase in the duration of the flights, more attention was paid to the study of the condition of the organism, and in particular of the cardiovascular system, during the flight. Procedures suitable for these goals were selected, and special small-scale equipment suitable for use on board a space ship was created. This significantly expanded the specialists'

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\* Numbers in the margin indicate pagination in the foreign text.

possibilities of evaluating the cosmonaut's condition during flight, including the study of the distribution of fluids in the body.

As early as the first flights it was noted that during the first days of the flight almost all the cosmonauts sensed flow of blood to the head, bloating of the face, weight in the head, an illusion of a reversed position of the body, etc. On the basis of these complaints and indirect objective data the transfer of blood to the upper part of the trunk and to the vessels of the cerebrum was hypothesized.

Theoretical reasons and the practice of space medicine in the conductance of a wide range of investigations on earth in conditions that imitate the effect of individual factors of space flight showed the promise of the use of rheography for these purposes, with tetrapolar rheography being the most ideal and promising. Its procedure is sufficiently informative, simple, and absolutely harmless; and if necessary it can be used repeatedly in very short time intervals, that is, the investigation can be uninterrupted. This is especially important in the conductance of functional tests.

Despite the relatively young age of rheography, in recent years a great deal of factual material has been accumulated, which makes it possible to establish a number of correlative relationships between the characteristics of the shape of the rheographic curve and the condition of the vascular system. The diagnostic possibilities of the quantitative analysis of the rheogram are expanding significantly. It is widely used during the pre- and postflight examination for study of local vascular reactions both during rest and during the completion of various functional tests.

For the introduction of rheography into the practice of flight studies the creation of a new, special "on-board" rheograph was required. The first such instrument was used on board the "Soyuz-13" space ship, where a "Levkoy-3" two-channel rheoplethysmograph, designed for the study of blood flow of the cerebral vessels, was installed.

The practice of space medicine strongly demanded a more extensive

study of different vascular regions. In connection with this a new device was created, "Rheograph-2," which makes it possible to record a rheogram of the trunk, forearm and crus and a rheoencephalogram of the right and left hemispheres of the brain. An advantage of this device was that the original technical innovations in its construction, on the one hand, simplified the procedure of rheogram recording, and on the other hand, significantly increased the accuracy of the obtained results. Along with the study of local blood flow, the device makes it possible quantitatively to determine the cardiac output. Since the effect of weightlessness on the human organism in earth conditions is imitated only approximately, one can understand how valuable is the information obtained on board the space ship.

The experience of using the "Rheograph" in the study of the crews of the first expedition of the "Salyut-6" orbital station was extremely useful. The previously stated hypothesis of the redistribution of blood in the body received experimental confirmation. At the same time, the accumulated experience indicates that the cosmonauts do not all adapt to weightlessness in the same way. It was shown that in the first two weeks of space flight there were a regular increase of blood supply in the cerebral vessels and a marked decrease of blood supply in vessels of the crus by 15-20 percent as compared to data obtained on the earth before the flight.

Rheographic studies at different stages of the flight help to establish some features and regularities of the reactions of the circulatory system. Rheography during functional tests has not a little significance.

On the creation of negative pressure on the lower half of the body with the help of a "chibis" vacuum suit (vacuum--25 mm Hg for 2 minutes and 35 mm Hg for 3 minutes), the pulse blood supply of the cerebrum noticeably decreased and cerebral blood flow improved.

The conductance of such tests helps to detect hidden disturbances and to study and evaluate the compensatory capabilities of the cardio-

vascular system. A large number of rheographic studies have already been completed, including during the flight of the third expedition of the "Salyut-6" orbital station. The obtained results promote correct understanding of the occurring processes and make it possible to clarify the adaptation periods and to predict the future condition of the cosmonauts' health.